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THE MONIST.

THE FACTORS OF EVOLUTION.

THEIR GRADES AND THE ORDER OF THEIR INTRODUCTION.

THE usually recognised factors of evolution are at least five ; viz. : (1) Pressure of a changing *environment* affecting function and function affecting structure, and the changed structure and function inherited and integrated through successive generations indefinitely. (2) *Use and disuse* of organs reacting on growth-force and producing change in form, structure, and relative size of parts, and such change inherited and integrated through successive generations. (3) *Natural selection* among individuals of a varying progeny, of those most in accord with an ever-changing environment—or as it has been otherwise called “*survival of the fittest*” in each successive generation. (4) *Sexual selection*: the selection by the female, among varying male individuals all competing for her possession, of the strongest or the most attractive. Among mammals the selection is mainly of the strongest as decided by *battle*; among birds, of the most attractive as determined by splendor of color or beauty of song. (5) *Physiological selection*, or selection of those varieties, the individuals of which are fertile among themselves, but sterile or less fertile with other varieties and with the parent stock. This has also been called “*segregate fecundity*” by Gulick, and homogamy by Romanes.

These five factors are all usually but not universally recognised. The first two are Lamarckian, the second two Darwinian factors. In the Lamarckian factors the changes occur *during individual life*,

and the offspring is supposed to inherit them unchanged. In the Darwinian factors on the contrary the *changes are in the offspring*, and the individuals during life are supposed to remain substantially unchanged. The fifth factor has, only very recently, been brought forward by Romanes and Gulick and is not yet universally recognised; but we believe that with perhaps some modifications it is certain to triumph. (6) To these recognised factors of organic evolution must now be added, in *human evolution*, another and far higher factor, viz. conscious, voluntary *co-operation in the work of evolution*, conscious striving for the betterment of the individual and of the race. This factor consists essentially in the *formation and pursuit of ideals*. We call this a factor, but it is also much more than a factor. It stands in place of nature herself—it is a higher-rational nature using all the factors of physical nature for its own higher purposes. To distinguish the evolution determined by this factor from organic evolution, we often call it *progress*.

Underlying all these factors as their necessary condition, and therefore themselves not called factors, are two opposite operative principles, viz. *heredity and variability*. Like the conservative and progressive elements in society, one tends to fixedness, the other to change. The one initiates change, the other accumulates its effects in successive generations. The one tries all things, the other holds fast to whatever is good. They are both equally necessary to the successful operation of any or all of the factors.

Let us now compare these six factors, as to their grade or position in the scale of energy and as to the order of their introduction.

The first two—Pressure of the environment and Use and disuse, i. e. the Lamarckian factors—are the lowest in position, most fundamental in importance, and therefore most universal in their operation. They are therefore also first in the order of time. They precede all other factors and were *for a long time the only ones in operation*. For observe: all the selective factors, viz. those of Darwin and Romanes, are wholly conditioned on Reproduction; for the changes in the case of these are not in the individual life but only in the offspring. And not only so but they are also strictly *conditioned on sexual modes of reproduction*. For all non-sexual modes of

reproduction such as fission and budding are but slight modifications of the process of growth, and the resulting multitude of organisms may be regarded as in some sense *only an extension of the first individual*. There is thus a kind of immortality in these lowest protozoa. Of course therefore the identical characters of the first individual are continued indefinitely *except in so far as they are modified* in successive generations by the effect of the environment or by use and disuse of organs—i. e. by *Lamarckian factors*. In sexual generation, on the contrary, the characters of two diverse individuals are funded in a common offspring; and the same continuing through successive generations, it is evident that the inheritance in each individual offspring is infinitely multiple. Now the tendency to variation in offspring is in proportion to the multiplicity of the inheritance: for among the infinite number of slightly different characters, as it were offered for inheritance in every generation, some individuals will inherit more of one and some more of another character. In a word, sexual generation, by multiple inheritance, tends to variation of offspring and thus *furnishes material for natural selection*.

Thus then I repeat, all the selective factors are absolutely dependent for their operation upon sexual reproduction. *But there was a time when this mode of reproduction did not exist*. It is certain the non-sexual preceded the sexual modes of reproduction. I cannot stop now to give the reasons for believing this. I have already given them in some detail in a previous article* to which I would refer the reader. Suffice it to say now that the order of introduction of the various modes of reproduction culminating in the highest sexual modes is briefly as follows: (1) *Fission*. An organism of the lowest kind grows and divides into two. Each half grows to mature size and again divides; and so on indefinitely. In this case there is no distinction between parents and offspring. Each seems either or neither. (2) *Budding*. Growth-force concentrating in one part produces a *bud*, which continues to grow and individuate itself

* *Genesis of Sex*, *Pop. Sci. Monthly*, 1879, Vol. xvi. p. 167. *Revue Scientifique*, Feb. 14, 1880.

more and more until it separates as a distinct individual. This is a higher form than the last because in this case the individual is not sacrificed. Only a small part separates and the separated part is in some sense an *offspring*. We have therefore for the first time the distinction of parent and offspring. (3) By the *law of differentiation and localisation of functions*, the bud-forming function is next relegated to a special place and we now have a bud-forming organ. (4) By another general law, the law of *interior transfer*, the bud-forming organ is next transferred for greater safety to an interior surface and thus *simulates* an ovary, although not yet a true ovary or *egg-forming* organ. Examples of all these steps are found among existing animals.

Thus far reproduction is non-sexual. But now comes the great step, i. e. the introduction of sexual reproduction, in its lowest forms. (5) This simulated ovary or bud-forming organ becomes a true ovary or egg-forming organ; or rather, at first, a combination of ovary and spermary. The same organ prepares two kinds of cells, male and female, germ-cell and sperm-cell, which by their union produce an egg which develops into an offspring; and not only an offspring in the sense of a separated part of a previous individual, but in some sense a new creature, the creation of a *new individual*. There is an enormous difference and even contrast between this and all preceding modes. In non-sexual modes one individual becomes two; in this, two individual cells unite to form one. It is an expensive, even wasteful mode unless attended with some great advantage. The nature of this advantage we will presently see.

Thus far we have given only the lowest form of sexual generation. The two sexual *elements* only, germ-cell and sperm-cell are separated from each other, but not yet even the sexual organs, ovary and spermary, much less the sexual individuals, male and female. (6) The sex-element-forming function is next differentiated and localised in two different organs, ovary and spermary, but not yet in two different individuals. This is hermaphroditism so common in plants and in lower animals. (7) The already separated sexual organs are next localised in different individuals, and we now have male and female individuals. This is the case in many plants

and in all the higher animals. (8) And finally these male and female individuals become more and more diverse in character.

The object of this whole process of separation, first of the elements, then of the organs, then of the individuals, and last the increasing divergence of the individuals, is undoubtedly the funding of more and more diverse characters in a common offspring; and thus by increasing multiplicity of inheritance to insure larger variation in offspring and thereby furnish more abundant material for natural selection. This is far more than a compensation for the apparent wastefulness of this mode of reproduction.

If then the non-sexual preceded the sexual modes of reproduction, evidently, *at first, only Lamarckian factors could operate*. Evolution was then carried forward wholly by changes in the individual produced by *the environment* and by *use and disuse of organs*, continued and increased through successive generations indefinitely. It is probable therefore that for want of the selective factors, the rate of evolution was at first comparatively slow; unless indeed, as seems probable, the earliest forms were, as the lowest forms are now, more plastic under pressure of physical conditions than are the present higher forms. The great contrast between the Lamarckian and Darwinian factors in this regard, and the slowness of change *now* in higher forms under *Lamarckian factors alone*, is best shown in plants where either kind of factors may be used at pleasure. In these, if we wish to *make* varieties, we propagate by seeds—sexual reproduction—but if we wish to *preserve* varieties, we propagate by buds and cuttings—non-sexual reproduction.

We have taken the two Lamarckian factors together, in contrast with the Darwinian. But even in the two Lamarckian factors there is a great difference in grade. Undoubtedly the lowest and first introduced was pressure of the *physical environment*. For even *use and disuse* of organs implies some degree of volition and voluntary motion, and therefore already some advance in the scale of evolution.

With the introduction of sex another entirely different and higher factor was introduced, viz. *natural selection*, among a varying progeny, of the fittest individuals. We have already seen how

sexual generation produces variation of offspring and how this furnishes material for natural selection. As soon, therefore, as this form of generation was evolved, this higher factor came into operation, and immediately, as it were, *assumed control* of evolution, and the previous factors *became subordinate* though still underlying, conditioning, modifying the higher. The result was an immediate increase in the speed and in the diversity of evolution. It is very worthy of note too, that it is in the higher animals, such as birds and mammals, where we find the highest form of sexual generation, where the diversity of funded characters and therefore the variation in the offspring is the greatest, and natural selection most active: it is precisely among these that the Lamarckian factors are most feeble, because during the most plastic portion of life the offspring is removed from the influence of the physical environment and from the effects of use and disuse, by their enclosure within the womb or within a large egg well supplied with nourishment. In these, development is already far advanced before Lamarckian factors can operate at all.

Next I suppose *Physiological selection* or Romanes's factor came into operation. After the introduction of sex, it became necessary, that the individuals of some varieties should be in some way *isolated*, so as to prevent the swamping of varietal characters as fast as formed, in a common stock by cross breeding. In very low forms with slow locomotion, such isolation might easily take place accidentally. Even in higher forms, changes in physical geography or accidental dispersion by winds and currents, would often produce *geographical isolation*; and thus by preventing crossing with the parent stock, secure the formation of new species from such isolated varieties. But in order to insure in all cases the preservation of commencing species, *sexual isolation* was introduced or evolved as I suppose later, and according to Romanes somewhat as follows:

All organs are subject to variation in offspring, but none are so sensitive in this regard as the reproductive organs; and these in no respect more than in relative fertility under different conditions. Suppose then the offspring of any parent to vary in many directions. By cross-breeding among themselves and with the parent stock,

these are usually merged in a common type, their differences pooled, and the species remains fixed or else advances slowly by natural selection, along *one line*, as physical conditions change in geological time. But from time to time there arises a variation in the reproductive organs of some individuals, of such kind that these individuals are fertile among themselves, but sterile or less fertile with other varieties and with the parent stock. Such individuals are *sexually isolated* from others, or *sexually segregated* among themselves. Their varietal differences of all kinds are no longer swamped by cross-breeding, but go on to increase until they form a new species. It is evident then, as Romanes claims, that natural selection alone tends to *monotypal* evolution. Isolation of some sort seems necessary to *polytypal* evolution. The tree of evolution under the influence of natural selection alone grows palm-like from its terminal bud. Isolation was necessary to the starting of lateral buds, and thus for the *profuse ramification* which is its most conspicuous character.

Next, I suppose, was introduced, *sexual selection*, or contest among the males by battle or by display, for the possession of the female, the success of the strongest or the most attractive, and the perpetuation and increase of these superior qualities of strength or beauty in the next generation. This I suppose was later, because connected with a higher development of the psychical nature. This is especially true when beauty of color or song determines the selection. As might be supposed therefore, this factor is operative only among the highest animals, especially birds and mammals, and perhaps some insects.

Next and last, and only with the appearance of man, another entirely different and far higher factor was introduced, viz. *conscious, voluntary co-operation in the work of evolution*—a conscious voluntary *effort to attain an Ideal*. As already said, we call this a factor, but it is much more than a factor. It is another nature working in another world—the spiritual—and like physical nature using all factors, but in a new way and on a higher plane. In early stages man developed much as other animals, unconscious and careless whither he tended and therefore with little or no voluntary effort to

attain a higher stage. But this voluntary factor, this striving toward a goal or ideal, in the individual and in the race, increased more and more until in civilised communities of modern times it has become by far the dominant factor. Reason, instead of physical nature, takes control, though still using the same factors.

Now, in this whole process, we observe two striking stages. The one is the introduction of Sex, the other the introduction of Reason.* They might be compared to two equally striking stages in the evolution of the individual, viz. the moment of *fertilisation* and the moment of *birth*. As the ontogenic evolution receives fresh impulse at the two moments of fertilisation and of birth; so the evolution of the organic kingdom at the two periods mentioned. With the appearance of *sex*, three new and higher factors are introduced, and these immediately assumed control and quickened the rate of evolution. With the appearance of reason in man another and far higher factor is introduced which in its turn assumes control, and not only again quickens the rate, but elevates the whole plane of evolution. This voluntary, rational factor not only assumes control itself, but transforms all other factors and uses them in a new way and for its own higher purposes.

This last is by far the greatest change which has ever occurred in the history of evolution. In organic evolution nature operates by necessary law without the voluntary co-operation of the thing evolving. In human progress man voluntarily co-operates with nature in the work of evolution and even assumes to take the process mainly into his own hands. Organic evolution is by *necessary* law, human progress by *free*, or at least by *freer*, law. Organic evolution is by a *pushing* upward and onward from below and behind, human progress by an aspiration, an attraction toward an ideal—a *pulling* upward and onward from above and in front.

*By Reason I mean the faculty of dealing with the phenomena of the inner world of consciousness and ideas, or *reflection* on the facts of consciousness. Animals live in *one* world, the outer *world of sense*; man in *two* worlds, in the outer world like animals, but also in the inner and higher *world of ideas*. All that is characteristic of man comes of this capacity of dealing with this inner world. In default of a better word I call it Reason. If any one can suggest a better word will gladly adopt it.

This great change may well be likened to a *birth*.* Spirit or Reason or the Psyche—call it what you like—was in embryo in animals in increasing degrees of development through all geological times and came to birth and capacity of free activity, became free spirit investigating its own phenomena in man. In animals the evolution of Psyche was the unconscious result of organic evolution. In man the Psyche is *born* into a new world of freer activity and undertakes to develop itself.

It may be well to stop a moment and show briefly some of the striking differences between organic and human evolution, differences resulting wholly from the introduction of this new factor, or rather this evolution on a new and higher plane.

(1) In organic evolution the fittest are those most in *harmony with the environment* and therefore they *survive*. In human evolution the fittest are those most *in harmony with the ideal*, and often, especially in the early stages of evolution, during the dominance of natural selection, they *do not survive* because not in harmony with the social environment.

(2) In organic evolution the weak, the helpless, the unfit in any way, *perish*, and ought to perish, because this is the most efficient way of *strengthening the blood*, or *physical nature*. In human evolution the weak, the helpless, the physically unfit, are *sustained*, and ought to be sustained, because sympathy, love, pity *strengthens the spirit or moral nature*. But the spirit or moral nature is also sustained by, and conditioned on, the physical nature. In all our attempts therefore to help the weak we must be careful that we avoid poisoning the blood and weakening the physical health of the race. This we believe can and will be done by *rational education*, physical, mental, and moral. We only allude to this. It is too wide a subject to follow up here.

(3) In organic evolution the *form must* continually *change* in order to keep in harmony with the changing environment. In other words evolution is by constant *change of species*, genera, etc.; there

*See *Evolution and its Relation to Religious Thought*, Part iii. Chap. iv, where the writer's views are more fully brought out.

must be a continual evolution of *new forms*. In human evolution, and more and more as civilisation goes on, man modifies the environment so as to bring it in harmony with himself and his wants, and therefore there is *no necessity for change of form or making of new species of man*. Human evolution is not by modification of *form*—new species, but by modification of spirit—new planes of activity.

(4) In organic evolution as a higher factor arises it assumes control, and previous factors sink into subordinate position. But in human evolution the rational factor not only assumes control but transforms all other factors, using them in a new way and for its own higher purposes. Thus the Lamarckian factor—*environment*—is modified and even changed so as to affect suitably the human organism. This is *Hygiene* or *Sanitation*. Again, the various organs of the body and faculties of the mind are deliberately *used* (another Lamarckian factor) in such wise as to produce their highest efficiency. This is *education*, or *training*, physical, mental, moral. So also the selective factors are similarly transformed, and natural selection becomes rational selection. This is freely applied to domestic animals and with limitations imposed by reason itself will be applied to man.

(5) The way of evolution toward the highest, i. e. from Protozoa to man and from lowest man to the ideal man, is a *very narrow way*, and few there be that find it. In the case of organic evolution it is *so* narrow, that once get off the track and it is impossible to get on again. No living form of animal is now on the way to form man, can by any possibility develop manward. They are all gone out of the way. They are all off the trunk line. The golden opportunity is past. The tree of evolution is an *excurrent* stem continuous to the terminal shoot—man. Once leave the main stem as a branch, it is easy to continue growing in the direction chosen, but impossible to get back again on the straight upward way to the highest. In human evolution whether individual or racial, the same law holds, but with a difference. If an individual or a race gets off from the straight and narrow way toward the highest, the Divine ideal, it is *hard* to get back on the track; hard but not

impossible. Man's own effort is the chief factor in his own evolution. By virtue of his self-activity, and through the use of reason, man alone is able to rectify an error of direction and return again to the deserted way.

REFLECTIONS ON THE ABOVE PRINCIPLES AND THEIR APPLICATION TO SOME QUESTIONS OF THE DAY.

I.

Just now there is much controversy in regard to the factors of evolution. Both Darwin and Spencer, the two greatest expounders of the modern theory of evolution, acknowledge and insist upon at least four factors; viz. the two Lamarckian and the two distinctively Darwinian. The only difference between them is in the relative importance of the two sets; Spencer regarding the former and Darwin the latter as the more potent. But some late Darwinians have gone far beyond Darwin himself in their estimate of the power of the most distinctive Darwinian factor, viz. natural selection. Weismann and Wallace have each written a book, and Lankester many excellent articles to show that natural selection is the one sole and sufficient cause of evolution, that changes during the individual life whether by effect of the environment or by the use and disuse of organs *are not inherited at all*, that Lamarck was wholly wrong and that Darwin (in connection with Wallace) is the sole founder of the true theory of evolution, and finally that Darwin himself was wrong only in making any terms whatever with Lamarck.

The argument for this view has, perhaps, been most strongly put by Weismann and is based partly on experiments, but mainly on his ingenious and now celebrated theory of the *immortality of germ-plasm*. The animal body consists of two kinds of cells wholly different in function, somatic cells and germ-cells, including in this last the sexual elements both male and female. Somatic cells are modified and specialised for the various functions of the body; germ-cells are wholly unmodified. The somatic cells are for the conservation of the *individual* life, germ-cells for the conservation of the *species*. Now according to Weismann, *inheritance is only through germ-cells*. Environment affects only the somatic cells and there-

fore changes produced by environment cannot be inherited. Sexual generation was introduced for the purpose of producing variability in progeny and thus furnishing material for natural selection, as this was the only means of evolutionary advance. Weismann made many experiments on animals, especially by mutilation, to show that somatic changes are not inherited.

We shall not argue this question but content ourselves with making three brief remarks.

1. If the views presented in this article be true, then the Lamarckian factors must be true factors, because *there was a time when there were no others*. They were necessary therefore to start the process of evolution, even if no longer necessary at present.

2. But if the Lamarckian factors were ever operative, *they must be so still*, though possibly in a subordinate degree. A lower factor is not abolished, but only becomes subordinate to a higher factor when the latter is introduced. Thus it may well be that Lamarckian factors are comparatively feeble at the present time and among present species, especially of the higher animals, and yet not absent altogether. In the earliest stages of evolution there was a complete *identification of germ-cells and somatic cells*—of the individual with the species. In such cases, of course, the effect of environment must be inherited and increased from generation to generation. But the differentiation of germ and somatic cells was not all at once; it was a *gradual process*, and therefore the effect of the environment *on the germ-cells through the somatic cells* must have continued, though in decreasing degree, and still continues. The differentiation is now, in the higher animals, so complete that germ-cells are probably not at all affected by changes in somatic cells, unless these changes are *long continued in the same direction and are not antagonised by natural selection*.

3. It is a general principle of evolution that *the law of the whole is repeated with modifications, in the part*. This is a necessary consequence of the Unity of Nature. We ought to expect therefore and do find, that the order of the use of the factors of evolution is the same in the evolution of the *organic kingdom*, in the evolution of *each species*, and in the evolution of *each individual*. In all these

the physical factors are first powerfully operative, then become subordinate to organic factors, and these in their turn to psychical and rational factors. Therefore, as the individual in its early stages, i. e. in embryo and infancy, is peculiarly plastic under the influence of the physical environment and afterwards becomes more and more independent of these : so a species when first formed is more plastic under the influence of the Lamarckian factors and afterwards becomes more rigid to the same. And so also the organic kingdom was doubtless at first more plastic under Lamarckian factors, and has become less so in the present species, especially of the higher animals. The principal reason for this, as we have already seen, is the increasing differentiation of germ and somatic cells, and the removal of the former to the interior where they are more and more protected from external influence.

II.

Some evolutionists—the materialistic—insist on making human evolution identical in all respects with organic evolution. This we have shown is not strictly true. The very least that can be said is that a new and far more potent factor is introduced with man, which modifies greatly the process. But we may claim much more, viz. that evolution is here on a wholly different and higher plane. The factors of organic evolution are indeed still present and condition the whole process ; but they are not left to be used by nature alone. On the contrary, they are used in a new way and for higher purposes by Reason.

But by a revulsion from the materialistic extreme, some have gone to the opposite extreme. They would place human progress and organic evolution in violent antagonism, as if subject to entirely different and even opposite laws. But we have also shown, that although the distinctive human factor is indeed dominant, yet it is underlaid and conditioned by all the lower factors—that these lower factors are still necessary as the agents used by Reason.

III.

We have already alluded to Weismann's and Wallace's views, but there is one important aspect not yet touched.

If Weismann and Wallace are right, if natural selection be indeed the only factor used by nature in organic evolution and therefore available for use by Reason in human evolution, then alas for all our hopes of race-improvement, whether physical, mental, or moral ! All enlightened schemes of *physical culture* and of *hygiene*, although directed indeed primarily for the strength, health, and happiness of the *present generation*, yet are sustained and ennobled by the conviction that the physical improvement of the individual, by inheritance enters into a similar improvement of the race. All our schemes of *education*, intellectual and moral, although certainly intended mainly for the improvement of the individual, are glorified by the hope that the race is also thereby gradually elevated. It is true that these hopes are usually extravagant ; it is true that the whole improvement of the individuals of one generation is not carried over by inheritance into the next ; it is true therefore that we cannot by education raise a lower race up to the plane of a higher race *in a few generations* ; but there must be a small residuum, be it ever so small, carried forward by inheritance and accumulated from age to age, which enters into the slow growth of the race. If it be true that reason must direct the course of human evolution, and if it be also true that selection of the fittest is the only method available for that purpose ; then, if we are to have any race-improvement at all, the dreadful law of *destruction of the weak and helpless* must with Spartan firmness be carried out voluntarily and deliberately. Against such a course all that is best in us revolts. The use of the Lamarckian factors, on the contrary, is not attended with any such revolting consequences. All that we call education, culture, training, is by the use of these. Our hopes of race-improvement therefore are strictly conditioned on the fact that the Lamarckian factors are still operative, that changes in the individual, if in useful direction, are to some extent inherited and accumulated in the race.

IV.

We have said that the new factor introduced with man is a voluntary co-operation in the process of evolution, a conscious upward striving toward a higher condition, a pressing forward toward

an ideal. Man contrary to all else in nature is transformed, not in *shape* by external environment, but in *character by his own ideals*. Now this capacity of forming ideals and the voluntary pursuit of such ideals, whence comes it? When analysed and reduced to its simplest terms, it is naught else than the consciousness in man of his relation to the infinite and the attempt to realise the divine ideal in human character.

JOSEPH LE CONTE.